The Glass Industry
REG. U. S. PAT. OFF.

Vol. 13 JULY, 1932 No. 7

A Study of Pulsating Feeders for Molten Glass

By ROY E. SWAIN[1]

(Continued from the June, 1932, issue)

In Fig. 14 are shown types of reciprocating needles:

(A) from U. S. patent No. 810,167 to W. D. Morrison. Cam operated.

(B) from U. S. patent No. 820,479 to John H. Crosky. Hand operated.

(C) from U. S. patent No. 836,297 to H. M. Brookfield. Cam operated.

(D) from U. S. patent No. 1,481,688 to John W. Carnahan. Air operated.

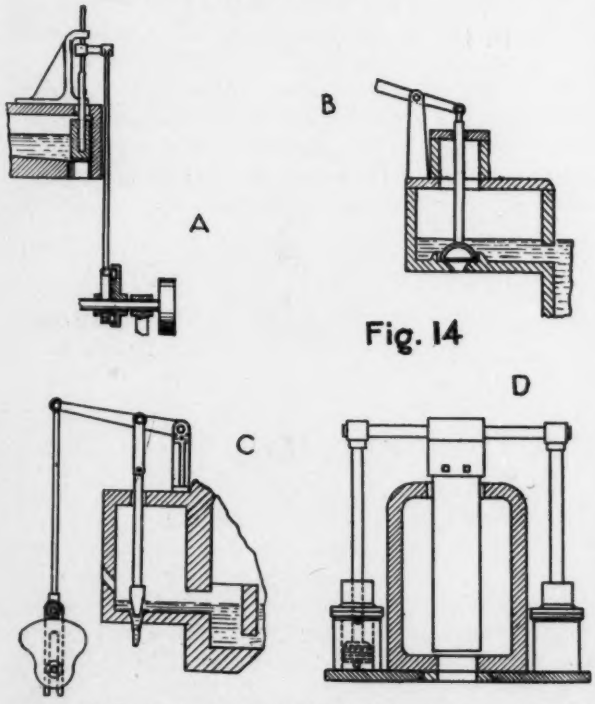

Fig. 14

Fig. 15 shows a number of blow backs by means of which the depending class is returned to the forehearth to reheat and await the indexing of the forming machine:

(A) from U. S. patent No. 1,260,428 to Wm. J. Miller.

(B) from U. S. patent No. 1,310,225 to J. Whittemore.

(C) from U. S. patent No. 1,462,491 to Wm. J. Miller.

(D) from U. S. patent No. 1,516,220 to Oliver M. Tucker.

(E) from U. S. patent No. 1,617,598 to George E. Howard.

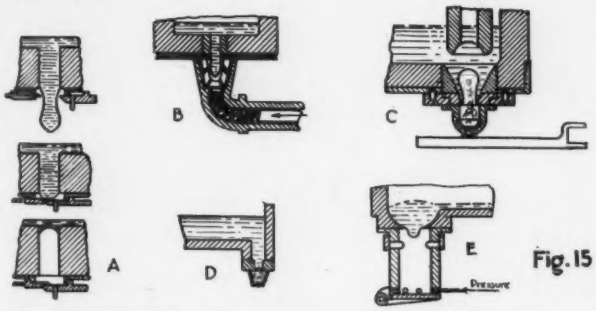

Fig. 15

Many shaped needles have been proposed. The most outstanding of these are shown in Fig. 16:

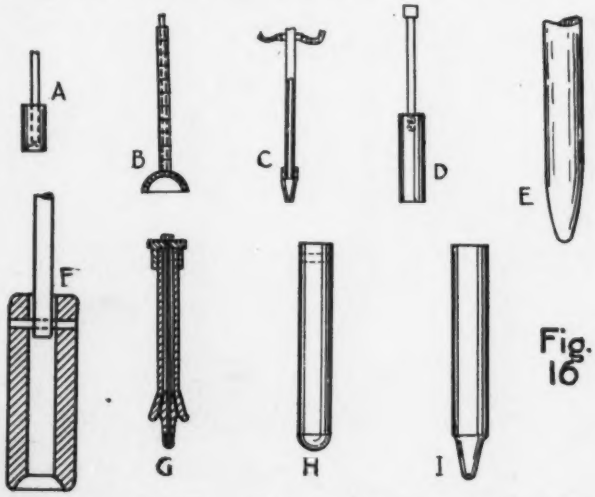

Fig. 16

(A) from U S. patent No. 810,167 to W. D. Morrison.

(B) from U. S. patent No. 820,479 to J. H. Crosky.

(C) from U. S. patent No. 836,297 to H. M. Brookfield.

(D) from U. S. patent No. 901,881 to George E. Cleveland.

(E) from U. S. patent No. 1,428,994, to L. D. Soubier

[1]Bethel Engineering Co., Huntington, Cal.

(F) from U. S. patent No. 1,462,491 to Wm. J. Miller.
(G) from U. S. patent No. 1,512,374 to L. D. Soubier.
(H) and (I) show common types used for experimental work.

As glass is a viscous material slight changes in the shape of the needle will have but little or no effect upon the action of the needle. A pointed needle may reach through the orifice and insure the returning of the depending glass into the bushing for reheating.

In Fig. 17 are shown some of the novel constructions of needles ranging from the straight shaft to the more complicated types:

(A) [See Fig. 16 (C)] from U. S. patent No. 836,297 to H. M. Brookfield shows a water cooled core and short needle.
(B) [See Fig. 16 (D)] from U. S. patent No. 901,881 to George E. Cleveland shows a cylindrical needle threaded at one end for attaching it to a shaft or rod.
(C) [See Fig. 16 (H)] from U. S. patent No. 1,151,393 to John Rau is attached by the means of an eye.
(D) from U. S. patent No. 1,551,526 to Frank O'Neill shows a needle attached to a water cooled core.
(E) from U. S. patent No. 1,621,426 to Wm. J. Miller shows a built up needle with a water cooled core.
(F) from U. S. patent No. 1,635,439 to A. L. Schram shows a plunger or needle reinforced with metal.

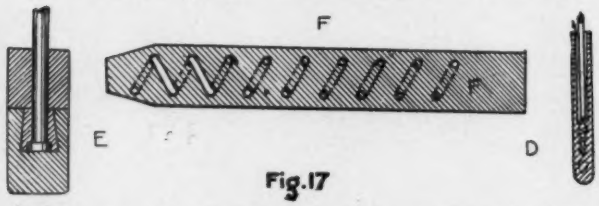

Fig. 17

With a few exceptions none of the inventors of forehearth feeding equipment have expected to operate the forehearth without the use of additional heat. In Fig. 18 types of proposed heating units are shown:

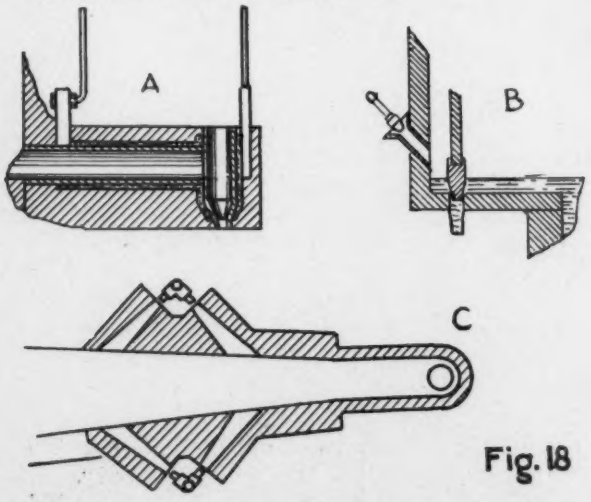

Fig. 18

(A) from U. S. patent No. 805,067 to H. K. Hitchcock shows heating by means of electrical resistance.
(B) from U. S. patent No. 883,779 to H. M. Brookfield shows the early use of the burner in the nose of the forehearth.
(C) from U. S. patent No. 1,512,566 to Tucker and Reeves gives an arrangement of burners.

As an aid to heating many have used heat insulating material about the forehearth and in Fig. 19 we have examples of the heat insulated forehearths:

(A) from U. S. patent No. 1,196,848 to Enoc T. Ferngren.

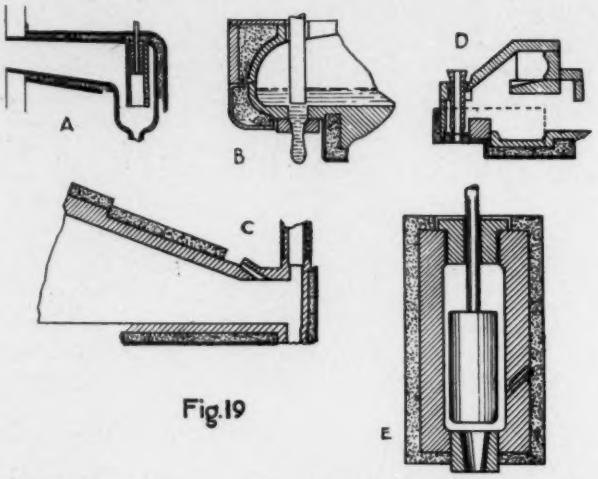

Fig. 19

(B) from U. S. patent No. 1,466,367 to E. H. Lorenz.
(C) from U. S. patent No. 1,516,220 to Oliver M. Tucker, et al.
(D) from U. S. patent No. 1,544,987 to George N. Howard.
(E) from U. S. patent No. 1,621,426 to Wm. J. Miller.

The stream of glass is often colder or at least less fluid on one side than on the other so we find a great many devices proposed for the purpose of breaking up this condition. Fig. 20 illustrates a number of these:

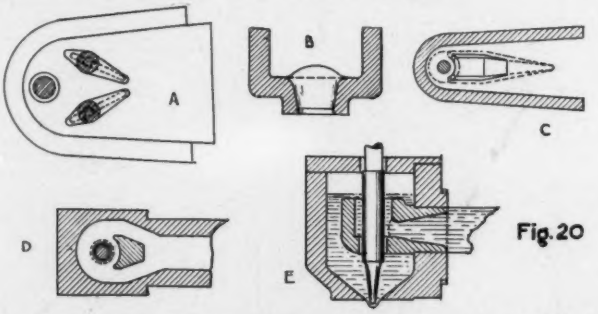

Fig. 20

(A) from U. S. patent No. 1,481,331 to L. D. Soubier.
(B) from U. S. patent No. 1,490,930 to Richard La France shows a raised portion of the floor of the forehearth for the purpose of causing the glass to flow into the orifice from opposite sides.
(C) from U. S. patent No. 1,618,271 to Albert N. Cramer is a similar arrangement.
(D) from U. S. patent No. 1,633,044 to L. D. Soubier.
(E) from U. S. patent No. 1,647,541 to John Rau.

Regenerative furnaces are subject to periodic heat variations due to the reversing of the fires, etc. To prevent this affecting the forehearth and for the purpose of conserving the

more expensive forehearth heat, baffles have been set up between the tank and the forehearth.

Some of these are shown in Fig. 21:

(A) from U. S. patent No. 820,479 to J. H. Crosky shows a combination baffle and skimmer.

(B) from U. S. patent No. 836,297 to H. M. Brookfield.

(C) from U. S. patent No. 1,151,393 to John Rau.

(D) from U. S. patent No. 1,520,229 to Enoc T. Ferngren shows an adjustable baffle.

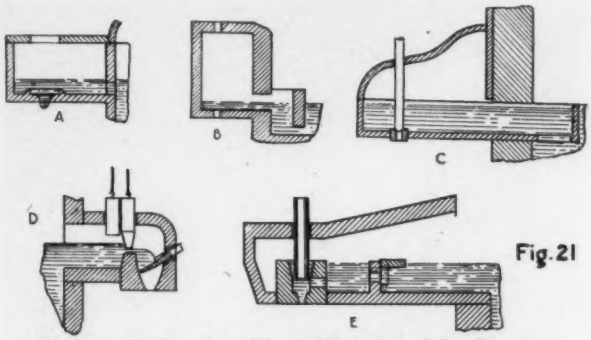

Fig. 21

(E) from U. S. patent No. 1,491,067 to John Rau.

Bad glass gives the feeder operator trouble and a number of skimmers and other means for drawing glass from below the surface have been devised. A, B, C, and E of Fig. 21 illustrate these.

The makers of optical glass stir their glass to secure homogeneity and the feeder operators have adopted this method of breaking up lumps, cold streaks, cords, etc. Some of the devices for doing this are shown in Fig. 22:

(A) from U. S. patent No. 1,612,658 to L. D. Soubier.

(B) from U. S. patent No. 1,618,313 to L. D. Soubier.

(C) from U. S. patent No. 1,626,705 to L. D. Soubier.

(D) from U. S. patent No. 1,631,061 to C. H. Rankin.

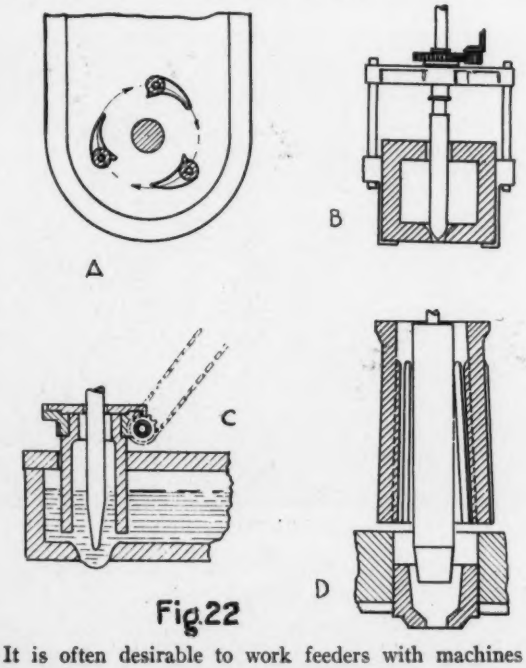

Fig. 22

It is often desirable to work feeders with machines not designed for feeder work and some feeders have been designed without making clearance for the forming machine. Some of the devices for transporting the glass to the forming machine are shown in Fig. 23:

(A) U. S. patent No. 836,297 to H. M. Brookfield.

(B) from U. S. patent No. 854,511 to W. A. Mansfield.

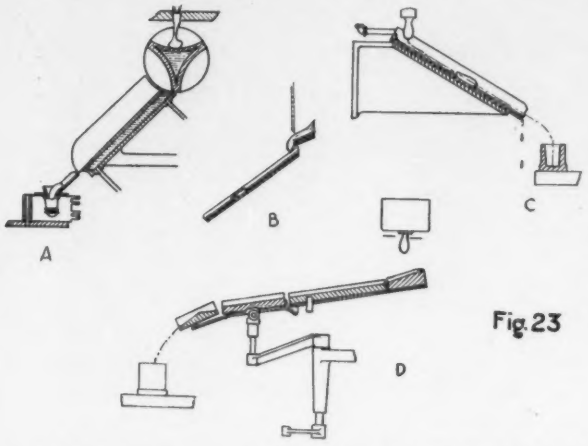

Fig. 23

(C) from U. S. patent No. 1,199,108 to Karl E. Peiler (cooling and lubricating).

(D) from U. S. patent No. 1,373,202 to Karl E. Peiler. Oscillating between two or more machines.

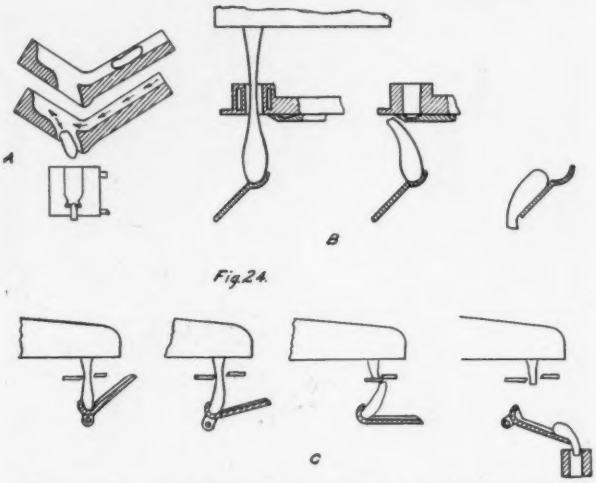

Fig. 24

In pressing or blowing it is sometimes desirable to have the hotter glass in the bottom of the blank or mold. Several devices have been suggested to accomplish this. Some of these are shown in Fig. 24:

(A) from U. S. patent No. 1,451,707 to Wm. J. Miller.

(B) from U. S. patent No. 1,470,023 to Edward Miller.

(C) from U. S. patent No. 1,497,929 to Edward Miller.

(To be concluded)

ROLLING PROCESS FOR GLASSWARE. U. S. 1,859,957. 5/24/32. Robert W. Canfield, West Hartford, Conn., assignor to Hartford-Empire Company, Hartford, Conn. Filed 5/16/29.

SHEET GLASS APPARATUS. U. S. 1,860,044. 5/24/32. Luke C. Mambourg, Lancaster, O., assignor to Libbey-Owens-Ford Glass Company, Toledo, O. Filed 5/8/28.

APPARATUS FOR PRODUCING LAMINATED GLASS. U. S. 1,860,067. 5/24/32. Daniel Adams, Ann Arbor, Mich., assignor to Libbey-Owens-Ford Glass Company, Toledo, O. Filed 2/20/28.

METHOD AND APPARATUS FOR PRODUCING SHEET GLASS. U. S. 1,860,082. 5/24/32. John L. Drake, Toledo, O., assignor to Libbey-Owens-Ford Glass Company, Toledo, O. Filed 1/21/28.

The Manufacture of Rolled Plate

By ERNST LUTZ*

This work has been revised, so far as the English and the technical expressions are concerned, by F. W. Preston, who has also added a number of notes relating in general to the special conditions of American practice; but it must be understood that the opinions expressed in the text are those of Mr. Lutz, and neither the Editor nor Dr. Preston accepts responsibility for them.

(*Continued from the June, 1932, issue*)

PLATE GLASS FROM TANK FURNACES

The experiments and methods hitherto described all originate in the pot furnaces that have held their own for so long a time in the manufacture of plate glass. However, long ago the tank furnace came under consideration because it could be operated on a cheaper and continuous basis, and had already proved good in the manufacture of other kinds

FIG. 235

of glass. It is inevitable that the pot furnace is subjected to very great fluctuation of temperature. This not only shortens its life but also increases its consumption of fuel per ton of glass as compared with more continuously working furnaces.† The expenditures for the pots which must constantly be replaced by new ones exceed in the long run the expenditures for repairs to the tanks. The pots which must be lifted from the furnace for every casting suffer a great deal from this and their life is very limited; besides, their handling during the melting and refining requires extraordi-

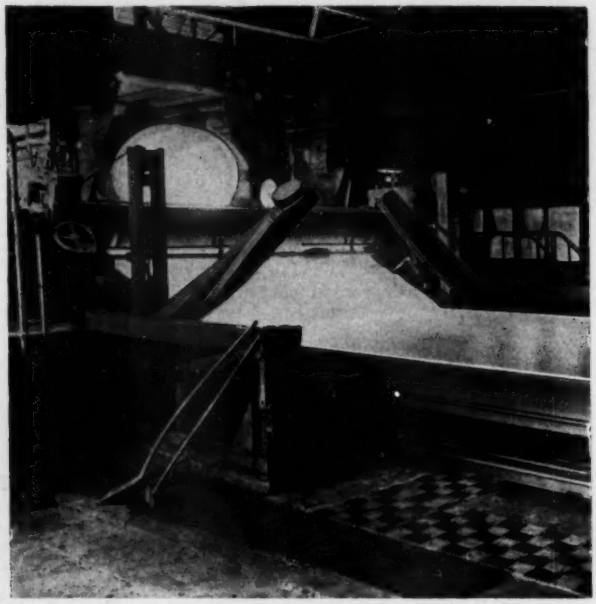

FIG. 235A

nary skill, and the least carelessness causes bad glass or breaking of the pots.

But it was not possible simply to accept for the manu-

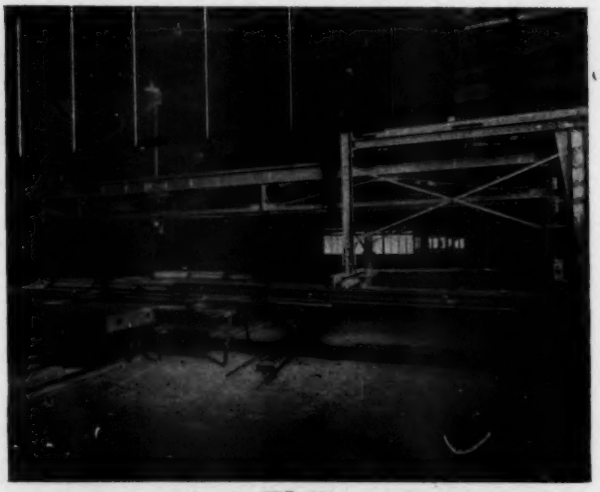

FIG. 236

facture of plate glass the tank furnace which had proved good in the window glass production. (See Dralle-Keppler, Die Glasfabrikation, chapter 8.) As better quality and larger quantities were required, a great deal more was demanded both from a thermal standpoint and from the point

* Of Dessau, Germany. This work is appearing in German in the new edition of *Dralle-Keppeler*, "Die Glasfabrikation."

FOOTNOTE: In the Figures, originally prepared for use eventually in the new edition in the German language of *Dralle-Keppeler*, "Die Glasfabrikation" in 1931, dimensions are given in metres (m) and millimetres (mm). We would like to have given these in feet and inches but the translation and the making of nearly two hundred and fifty new illustrations would have involved a prohibitive loss of time and expense. To some of our readers the metric system is as familiar as the English units; for the others we may say that a metre is approximately 40 inches, and a millimetre is approximately 1/25 of an inch. A thousand millimetres, of course, go to a metre.—F. W. P.

† Records obtained by G. E. Howard do not show that tank furnaces are much more efficient thermally than pot furnaces.—F. W. P.

of chemical homogeneity. Protracted experiments and many changes of the furnaces were required before the glass mass could always and safely be brought to a condition fit for

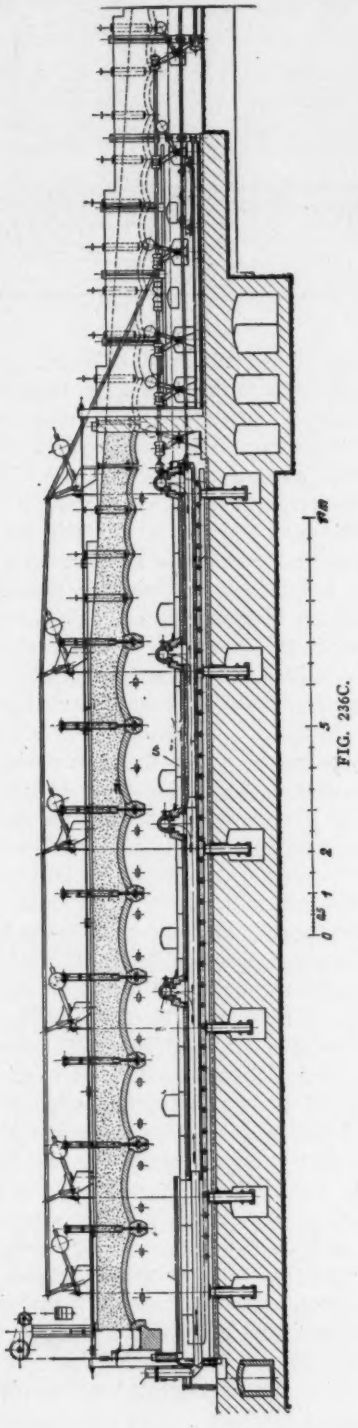

FIG. 236C.

use. The form of the tank furnace, the action of the flames, the position and construction of the burners had to be arranged in such a way that the glass from the batch of one charge did not mix with another charge or stay inactive. With the older forms of tank structures these requirements could not be met adequately. It was necessary to control the temperatures of all zones of the furnace in such a way that the entire contents of the tank were kept in motion.

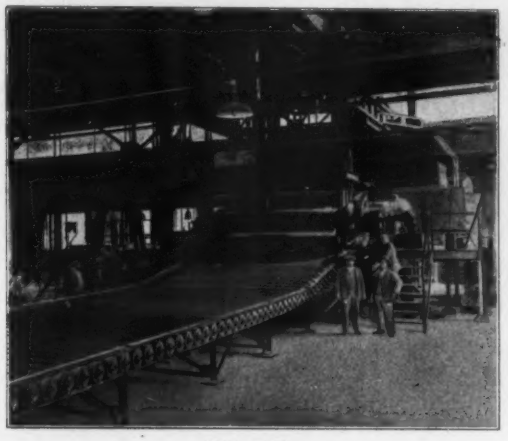

FIG. 236A.

By floaters or color tests information can be obtained about this motion. Dead pockets do not only destroy the homogeneity of the finished glass mass but also impair considerably the capacity of the furnace.

FIG. 236B.

These are the problems that were to be solved in connection with different discharging methods. The principal ones of these methods are the drawing method which, as already stated above, today plays a considerable role for plate glass manufacture, the dipping method, and the flowing method.

For information about the drawing method see Dralle-Keppeler "Die Glasfabrikation" chapter 10, 3rd paragraph. The dipping method was adopted in Bavaria by the two firms of S. Bendit & Söhne and Bayerische Spiegelglasfabriken Bechmann-Kupfer Aktiengesellschaft; the flowing method, probably the most important method for the future, was taken up by the Ford Motor Co.

THE DIPPING METHOD (LADLING)

By hand or by means of a mehcanical device, an iron ladle takes the glass carefully from the tank and pours it into a rolling machine. The rolled sheet is taken up by a table which moves below the rolling machine and carries the

sheet to the lehr. This method appears to be the same as the one applied long since to the manufacture of figured glass. Plate glass of the best quality has been successfully

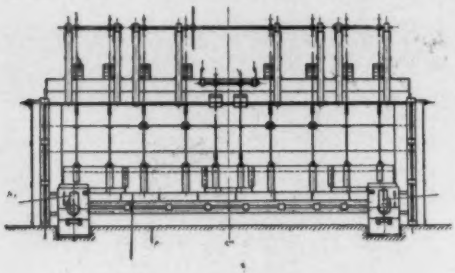

FIG. 236D.

made in large sheets by this method. The glass is of such purity that one can be sure that a great percentage of the total production can be used for silvering. In order not to spoil the glass mass in taking it out, the ladle must be filled

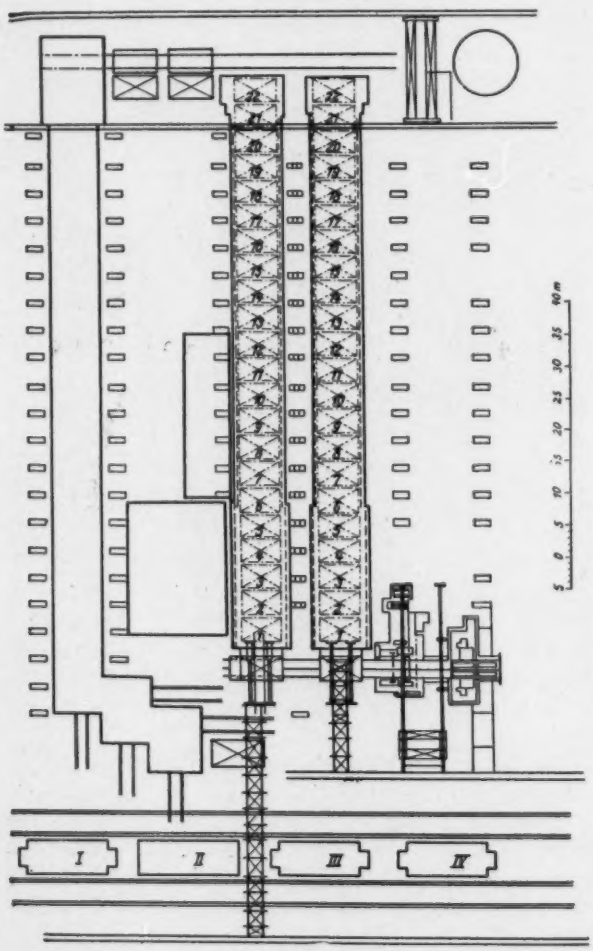

FIG. 236E.

very carefully by a turning motion, the lower edge cutting into the glass mass. This is a matter of course, anyway, as the resistance of the glass is too great to permit bodily playing the ladle under the surface. Care must be taken that during the turning of the ladle, i.e., during the cutting in of the ladle into the glass mass no see-sawing motion is made with the handle; this has long been a rule observed

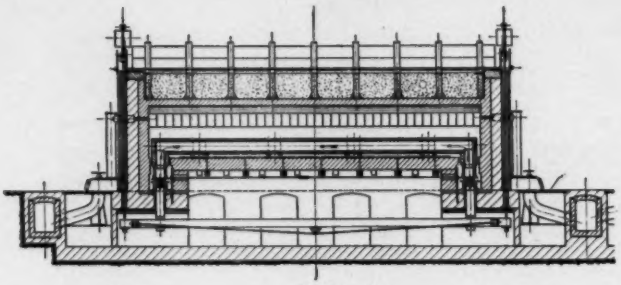

FIG. 236D¹.

in the ladling of figured glass. The ladling introduces bubbles into the tank at the point where the ladle takes out a scoop; therefore it is essential for obtaining a good quality that enough time passes from one dipping to the next that one can be sure all bubbles are gone again. These pauses can last 45 minutes to 1 hour or even more, this depending on the conditions of the glass mass which one is used to work with and on the care and skill employed during the scooping. If several scooping points are installed and the dimensions of the tank furnace are built accordingly, the work can be divided so that the rolling machine and the lehr are fully utilized and the plates succeed each other in the customary time. One of the tanks in use has 6 scooping points.

The scoops or ladles served by hand can produce but small sheets as otherwise it would be too difficult to handle them. The iron of the scoop is cold compared with the temperature of the glass; consequently, a relatively large part of its contents stays in it during the pouring as a sort of crust.* Thus, the plate produced from it must be rather small. Therefore, the greater the capacity of the scoops, the smaller the percentage of the glass remaining in it. For information on the rolling machines in use, see volume I, page 559 and especially volume II, chapter 12 of Dralle-Keppeler, "Die Glasfabrikation," (1st edition). It must be pointed out that table and rolls are driven separately from each other; the table by an electric motor with reduction gears, the rolls by a more elastic belt-gearing so that in case foreign bodies get between the rolls no parts of the machine may break. It is also important that the starting and stopping of the table be performed without any jolting, to avoid concussions from which waves and other distortions of the sheets may arise. To this end a friction clutch is installed between motor and reduction gears as well as a magnetic brake which is engaged as soon as the table approaches its two end-positions and brings the table to a stop very gently.

The mechanical scoops employed up to date have a capacity of up to 11 cu. ft. Their oval opening is about 43½" long, 24" wide, and 24" deep. For comparison we repeat, that melting pots of the most customary size have a capacity of about 28¼ cu. ft. of which, however, at best 22¾ cu. ft. of glass come to the rolls, and of which at the

* Technically known as "the skull."—F. W. P.

most 15½ cu. ft. can profitably be poured out if a high quality glass plate is to be obtained, for, besides the fact that a portion of the glass mass is left in the pot, a further residue of the glass mass which would only slowly drop out cannot be put on the casting table or into the rolling machine because the danger of formation of bubbles is too great. The 11 cu. ft. iron scoop can almost entirely be filled up. Because of its round form, it delivers a larger percentage of its contents all at once, i.e., without forming drops when poured out. One may presume that of the 11 cu. ft. about 7¾ cu. ft. get into the rolled sheet. Therefore, a plate from the 11 cu. ft. scoop has a surface almost half as large as a plate from the 28¼ cu. ft. pot, the thickness being the same.

One may anticipate that as a result of further development of this method one will be able to operate with considerably larger ladles. If, furthermore, one succeeds in obtaining glass of consistently good quality from the tank, the significance of this method is proved already by the possibility of combining it for instance with a Bicheroux rolling machine. One then enjoys the advantages of both this machine and the tank furnace at the same time.

Herr Adolf Schild of Marktredwitz, Bavaria, reports upon the ladling method as follows: "One has succeeded in obtaining good plate glass by direct scooping from the tank into a Chance mill. In the beginning the trials did not look too hopeful, and not until construction and operation of the tank furnaces were perfected was one really able to produce in continuous succession a faultless silvering quality. In the meantime this way of manufacturing has proved good for a number of years. A continuous output of 85 per cent and more of best silvering quality is obtained with sufficient assurance."

The tank furnaces in operation for the time being are heated regeneratively with reversing flames and have a capacity of 330 ts. (350 short tons). The average melting effect is up to now from 2 to 2.2 lbs. per each square foot of total tank area per hour;* the total consumption of heat for the melting, rolling, and annealing amounts to about 2,360 calories per pound of molten glass, the loss in the gas producers being included. It should be pointed out that these figures do not represent a very up-to-date plant but refer to a plant which can be improved very much in respect to heating economy. But these results prove anyhow that it is very well possible to produce in suitably built and operated tank furnaces in a remunerative way a plate glass the quality of which is at least equal to that produced in pot furnaces.

The scooping and casting with steel ladles by hand is confined to scoops of not more than about 3¼ cu. ft. capacity and requires extraordinary care and skill, lest the glass be spoiled afterwards by the formation of bubbles. The suspension of the ladles on a small overhead trolley and their transportation from tank to machine correspond with the mechanisms used in the manufacture of figured glass.

The pauses between dips are determined by size, number and thickness of the glass sheets as well as by the tank efficiency; these pauses last on an average of 7 to 12 minutes. The glass must be of a certain stiffness in order to be fit for the casting and rolling. Each dipping point must be allowed sufficient time after every discharge to settle down so that the bubbles caused by the scoop are eliminated and the thermal homogeneity is restored. Therefore, several (mostly 4-5) discharging openings are installed on one tank through which the scooping is performed successively.

During the casting (Fig. 247), any direct falling of the glass onto the pouring plate or between the rolls of the machine must be avoided as this would cause bubbles by lapping over or folding of the glass mass. Consequently, the edge of the ladle must be set on the pouring plate of the machine with especial care, and the tilting over must be executed individually according to the stiffness of the glass and the peculiarities of the machine. A certain disadvantage of this method that cannot be denied is the fact that the particles of the glass, molten in tanks, have been more subjected to different conditions of temperature while they passed the furnace and this glass is much more inclined towards chemical inhomogeneity than is the case with glass molten in pots. Furthermore, by scooping with cold ladles additional thermal inhomogeneities are added to the glass mass not only during the dipping but also while the glass is carried in the ladle to the machine. These irregularities and those first enumerated demand special care in giving the right temperature to the machine and in the subsequent annealing. The sheets are shifted by hand with light stowing tools into a straight lehr. If the glass composition is such as to allow of favorable thermal expansion, a channel of 120 to 140 ft. length inclusive of the lengths of the preannealing chambers or ovens suffices, with narrow sheets, to guarantee good annealing and faultless evenness.

With this scooping-by-hand method, plate glass sheets up to 65 sq. ft. of 0.150″ to 0.355″ thickness have already been produced successfully for a number of years. The violent chilling of the glass in the ladles and during the pouring into the machine with several rolls causes a loss of about 40 per cent of the glass taken from the tank. This is why the manufacture of larger sheets by hand is out of the question.

In order to compete a plant was built with a mechanical scooping device which permits the manufacture of rough glass sheets up to 11½ ft. wide. (Figs. 248 and 249.)

In the same way as it is done by hand, the glass is scooped out of the tank by steel scoops which are carried by a travelling crane and is then rolled to any thickness in a big rolling machine. The transporting of the sheets into the lehr is done by electrically driven shifting trucks. Owing to the larger dimensions of the sheets, the structure of the lehr and the progress of the annealing curve must be more adapted to the peculiarities of tank glass than is necessary for the smaller sheets scooped by hand.

As this plant has been in operation for but little time and is still in a state of development, final conclusions cannot yet be drawn. However, considering the results obtained so far, one may well expect that the tank will soon be of great significance for the intermittent manufacture also of very large sheets of plate glass."

*About 40 sq. ft. of tank per ton of glass per day.—F. W. P.

METHOD OF THE FORD MOTOR COMPANY

A very important method which enables the production of sheets of every thickness, but which today is mainly used for sheets of small thickness, is that of the Ford Motor Co. at River Rouge and in St. Paul, Minnesota. After long and difficult tests this process was adopted for Ford's requirements in car windows and wind shields: (see THE GLASS INDUSTRY, New York, No. 1 of January, 1923, and No. 7 of July, 1924). With it, it was found possible to guide, intercept and roll a continuously-fed glass stream in such a way that a rough glass ribbon of $\frac{5}{16}$" thickness and about 42" width is produced, which can be ground and polished and yields sheets about 7/32" in thickness the quality of which serves their purpose. This success has caused astonishment and admiration among all who know the awkwardness of a flowing and congealing glass mass to which the qualities of plate glass have to be imparted. The following description and Figs. 237-241 are taken from the Belgian patent specification No. 310,938 and the journal referred to,

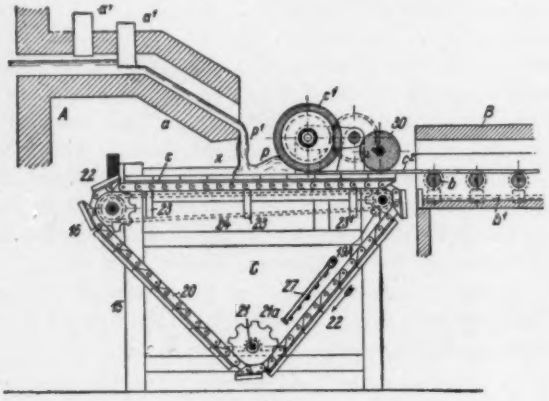

FIG. 237

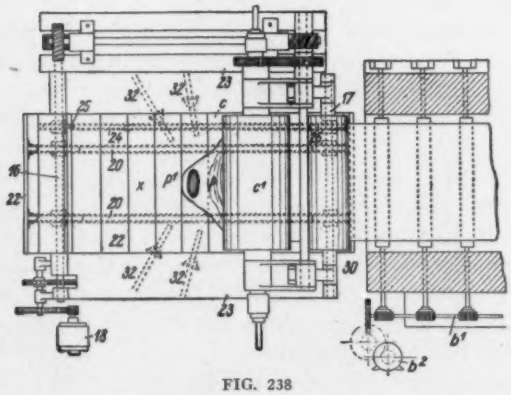

FIG. 238

The patents for this method and for the machinery required were applied for in the U. S. A. on April 13th, 1922.

As originally practiced at Highland Park the refined glass flows from the tank through the nozzles a on to the mill C. Immediately thereafter comes the lehr B in which the ribbon of glass is caught by a special device b, b_1 with the motor b_2; this device exerts a pulling action on the ribbon. The mill C consists of the caterpillar-table c, built up into an endless track, and of the water-cooled roll c_1, which is rigid in horizontal direction, but can be adjusted vertically to the desired glass thickness. The plates 22 which form the table surface are guided in rails 23 of the frame 15. Table and roll are jointly driven by an electric motor 18 and positively coupled with each other, so that the velocity of the table surface always equals the peripheral velocity of the roll.

FIG. 240

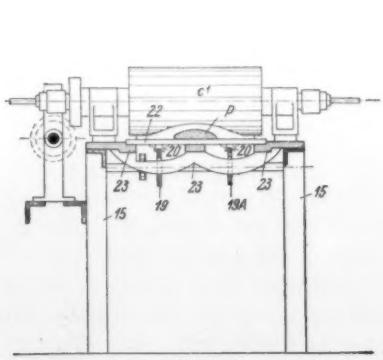

FIG. 239

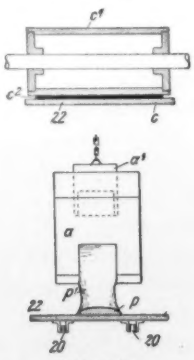

FIG. 241

The metallic plates 22 are carried by two chains 20, which run over the sprockets 19, 19A and 21a. The chains are driven from the shaft 16, i.e., from the two sprockets 19. The table surface therefore is pushed towards the roll c_1, causing the plates 22 on their upper horizontal path to be pushed against each other and to close up the gaps in between. In order to prevent shocks and subsequent humps in the table surface, a device for counteracting any tendency of the plate 22 to jam and to distort the table surface is provided. This device consists of a special chain and chain wheel combination 24, 25 and 26, in between the shafts 16 and 17.

The sprocket 25 sits loosely on the shaft 16. It is, however, turned by a keyed-on cam 25-A and a feather; a chain wheel on the other hand is rigidly keyed on to the shaft 17. Now as soon as there is a tendency for distortion of the table surface, i.e., as soon as the chain wheel 19 tries to move ahead relative to the chain wheel 19a, the drive is taken over by the chain connection 24, 25, 26; which causes the stretching of the lower line of the chain 24 and exerts a pulling action of the two sprockets 19-A on the chains 20, which counteracts the said tendency for jamming. The pull on the chains 20 cannot become too great, because the elasticity of the feather releases the driving force of the sprocket as soon as there is no phase difference of the chain wheels 19 relative to 19-A. The distortion of the table surface might also be avoided by arranging the guides 23 to embrace the table surface. With such an arrangement, however, the plates 22 are liable to get jammed in their guides, and again the plates 22 which rise upwards with the chain wheels 19 would not run smoothly into their guides. To avoid the chilling of the glass heap lying on the table, burners 32 are provided beneath the table surface. In case they have become too hot, the sections of the tables can be cooled with a water spray. The purpose of the roll 30 is to correct possible unevenness of the glass ribbon.

The slower table and roll are moving, the more time is left

for the glass heap to spread out, and the broader will be the glass ribbon. To ensure the desired width of ribbon continuously and uniformly, both the velocities of table surface and roll periphery must be accurately governed. With these velocities that of the lehr mechanism must at any time coincide; all motors are therefore checked by a single controller.

Later on the chain-table was replaced by a roll of about 44 inches diameter, as per Figs. 242 and 243. To offset unequal warming of this roll by the glass a special water-circulating system through the shaft was adopted. The water is preheated somewhat to avoid "checks" or cracks in the surface of the glass.*

FIG. 242

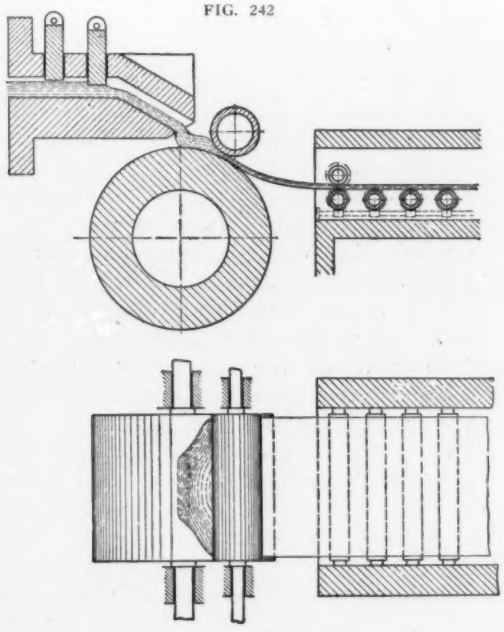

FIG. 243

This method is noteworthy for the way of feeding the glass to the roll. The stream of glass coming from the feeder a, must be so caught by the table with respect to the lower roll that turbulence and sputtering is avoided, as it would otherwise be quite impossible to produce a glass which, to any great extent, is free from bubbles. At the same time the glass must be so brought between table and roll respective to the lower and upper rolls that its quality is not impaired. In short, the flowing of the glass must be regulated in perfect accordance with the speed of the rolls and directed in such a way that it does not clog but rather a slight tension is executed by the rolls. The circumferential velocity of the lower roll is about 40 inches per minute. According to the patent specification this aim is attained by giving the stream of glass the form of a thick narrow vein p_1, which, on the table surface respective to the big roll, broadens out to a heap p. Due to the movement of the table surface respective to the big roll this spreading mainly goes in the direction of the movement itself, i.e., towards the top roll which, similarly to the behavior of the glass heap poured in front of the roll, ensures a natural transition into the width of the ribbon. The quantity of glass fed can be governed by a sliding valve a' in the feeder a; Fig. 237 shows a second sluice valve as reserve. The quality of the glass rolled and the operation of the whole plant is very much influenced by the temperature of the glass fed to it. This temperature can be regulated somewhat by special burners fitted in the feeder a. The quantity of the glass, the velocity of rolling and the said temperature must always be in a definite relation to each other, and means must therefore be provided to regulate them individually and at any moment.

(To be continued)

*Obtained by courtesy of "Deutsche Glastechnische Gesellschaft."

Optical Glass

THE production of optical glass (which was chiefly for the Navy Department) increased 20 per cent during the year 1931,—that is, from 2500 to 3,000 pounds. This glass was molded into lens and prism blanks of which 37,955 were made and is used by the Navy Department in constructing or repairing fire control instruments such as range finders, spotting glasses and binoculars. The melting, molding and annealing of glass for this purpose is largely routine, but the annealing is not always eminently satisfactory, especially when blanks are rather large. For instance, it is not particularly difficult to reduce the strain in a disc 7 inches in diameter and 1 inch thick to the desired minimum, but it is not so easy to anneal such discs so that the residual strain is equally distributed. In other words it is somewhat difficult to anneal a 7 inch disc symmetrically and unless the glass is symmetrically annealed its optical performance may not be entirely satisfactory.

A study of the cause of this lack of symmetry leads to the conclusion that temperature distribution in our annealing furnaces is not uniform. The furnaces are cast steel circular boxes about 30 inches in diameter and 6 inches deep, electrically heated and insulated with diatomaceous silica. Although the entire furnace is symmetrically built and insulated and the distribution of the heating current is uniform, there seem to be sufficient temperature gradients in the furnace to produce unsymmetrical strain unless the blanks are placed exactly in the center of the furnace. In annealing smaller blanks this gradient did not make itself evident as determined by the quality of the annealing.—*Bureau of Standards Ceramic Investigations*, 1931.

Mr. Cruikshank Enjoying Life in Tahiti

A note from Mr. J. W. Cruikshank, former Pittsburgh glass works consulting engineer, to Dr. F. W. Preston, also of the same profession:

"It is hot here with a good deal of rain; today it feels like an orchid hot house, so I am not at all energetic.

"I have a nice house right on the lagoon that originally belonged to Keable, the author.

"Most of my time goes in swimming and sailing, some gardening and photography.

"The mail comes in tomorrow (Feb. 27, 1932), the great monthly event which brings us in touch with the outside world."

Clam Shell Bucket

Clam-Shell Bucket. The Wellman Engineering Company, Cleveland, O., have just issued a new bulletin descriptive of the new Williams "Champion" clean-up rehandler clam-shell bucket which they believe will be of interest to many readers who are interested in equipment for unloading cars and hatches, cleaning up shallow piles of material, etc.

Glass Industry

ESTABLISHED 1920

The First Trade Journal Devoted Primarily to Glass Technology, Engineering, Raw Materials and Glass Factory Equipment and Operation

PUBLISHED MONTHLY

Copyright, 1932 by

GLASS INDUSTRY PUBLISHING COMPANY, INC.

24 West 40th Street, New York

Telephone CHickering 4—2354 Cable Address Glasdustry

G. W. Cooper, Managing Editor

Subscription Price..United States $2.00 a Year; Foreign $3.00
Single Copy .....25 Cents

Vol. 13 JULY, 1932 No. 7

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Reference to the contents of earlier issues of THE GLASS INDUSTRY can be found in THE INDUSTRIAL ARTS INDEX in many Public and Technical Libraries.

Dedicate Hall of Science for World Exposition

On June 1, exactly one year before the opening of the Century of Progress exposition—Chicago's 1933 World's Fair—a celebration centering about the dedication of the Hall of Science, a great nine-acre structure was held at the Exposition grounds. The dedication took place in the presence of scientists, representatives of foreign governments, business and civic leaders, with Dr. Frank B. Jewett of New York, chairman of the science advisory committee of the National Research Council, and President Rufus C. Dawes of the Exposition as the principal speakers. Elsewhere Chicago celebrated World's Fair Day with observances in public schools, women's clubs, business and civic organizations. Special radio programs from every Chicago station proclaimed the event.

A year before the opening day of Chicago's 1933 World's Fair, thirteen buildings are either already standing, approaching completion or under construction and a number more will be undertaken this summer. Ten million dollars, assured by a bond issue underwritten by Chicago citizens is providing adequate advance financing. Contracts aggregating more than $3,000,000 have already been signed by more than 150 great corporations, representing practically every phase of industry, either for the purchase of exhibit space, or for the erection of special buildings. Forty-four states of the Union have either appropriated money for participation, or appointed official state commissions to develop exhibits. Four territories have made appropriations for exhibits. A bill authorizing an appropriation of $1,000,000 for a Federal Building and exhibit has been passed by Congress and signed by President Hoover. Official acceptances to participate have been received from a number of foreign nations.

Although A Century of Progress Exposition does not open officially until June 1, 1933, enough buildings and exhibits are already in place inside the 9-foot high sheet metal fence to provide an interesting experience for visitors this summer. The Administration building with its modernistic architecture, the vast Travel and Transport building with its 125 foot dome suspended by cables, the great U-shaped Hall of Science and the Radio, Communications, and Electrical buildings comprising the Electrical Group are already standing.

Under construction are the Agricultural Group and the first three pavilions in the General Exhibits Group. In addition, the General Motors Corporation has started construction of its special building, the Chrysler Corporation and Sears, Roebuck & Company have completed plans for their special buildings. Drafting room work is being rushed on plans for the States group.

Visitors this summer will also see the replica group of buildings associated with the life of Abraham Lincoln, now virtually completed. These will include his birthplace near Hodgenville, Ky., his boyhood home in what is now Lincoln City, Ind., the Lincoln-Berry store at Salem, Ill., the Wigwam hall in which he was nominated for the presidency and rooms in his Springfield Home and the White House of the Civil War era.

Glass Men Meet at Keuka Lake

With a view to discovering means of increasing the effectiveness of scientific services to the glass industry, a group of glass men met at Dr. Littleton's cottages on Keuka Lake the week end of May 21.

Among others there were present, E. W. Tillotson, F. C. Flint, J. T. Littleton, Harold White, Donald Sharp and F. W. Preston.

Several others drifted in and out, including J. C. Hostetter, Dr. McCauley, Howard Lillie, and W. C. Taylor.

It was the general opinion that the American Ceramic Society, and the Glass Division thereof, had in recent years done a lot of good work, and had rendered a great deal of service to industry; that the General Secretary had effected a remarkable standard in very difficult circumstances; and that the division should put itself to some trouble to simplify its requirements and assist the society in moderating demands on its space and time.

The editorial committee of the division came in for many encomiums, so that their ears probably tingled at a distance, none of them being present.

The appointment of Dr. Scholes to the chair of glass technology at Alfred University, effective in July, was examined in connection with its possible bearing on the division's activities. The general feeling was one of satisfaction.

The preprinting of papers for distribution at the sessions was condemned; it was decided that preprinting well in advance would be welcome; failing that there should be no pre-printing.

A proposal of Harold White's, to issue only preprints (as transactions) till the end of the year, and then to issue complete volumes for each of the divisions, the only monthly publications of the society being a bulletin in the form of a trade paper or released to the trade papers, was given favorable consideration; it was beyond the scope of the gathering for immediate action. It was decided to seek the General Secretary's opinions on this and other matters.

THE MAN IN THE CROW'S NEST.
J. T. Littleton with nest above him and two young crows in his hands.

Some considerable debate centered around the way an author should prepare his papers; how he should abstract them; how far he should review the previous literature; his responsibility for stating an opinion on divergence of his conclusions from those of others. Responsibility for taking notice in print of later investigator's work, when divergence of conclusion resulted, was also urged. But in these matters, men differ, and beyond urging authors to communicate with each other and to try to reach a sound decision before printing, nothing much can be done. Some authors are so angular and some so dilatory, as correspon-

(*Continued on page* 126)

BAKED TROUT.
(passim) fringed by W. C. Taylor, J. C. Hostetter, F. C. Flint, J. T. Littleton, D. E. Sharp, E. W. Tillotson, H. E. White.

DONALD SHARP SWINGS INTO ACTION.
(Hammondsport in the background.)

ABOVE
THE CHAIRMAN AND HIS TRUSTEE.
E. W. Tillotson and Francis Flint.

THE CHESAPEAKE BOAT TEAM.
(Bosun tight, midshipmite, and crew of captain's gig.) Francis Flint heading into the wind.

Announcing

AMERICAN CYANAMID & CHEMICAL CORPORATION

Effective July 1st, 1932

IN ORDER to more effectively place at the disposal of its customers the combined technical, manufacturing, sales and shipping facilities of the Industrial Chemical and Insecticide units of the American Cyanamid Company and affiliated companies, American Cyanamid & Chemical Corporation have, as of July 1st, consolidated the activities formerly carried on by the following companies:

AMERICAN CYANAMID COMPANY
Industrial Chemical Division
AMERICAN CYANAMID SALES COMPANY
THE KALBFLEISCH CORPORATION
A. KLIPSTEIN & CO., INC.
JOHN C. WIARDA & CO., INC.
SUPERIOR CHEMICAL CO., INC.
FUMIGATORS SUPPLY COMPANY

All correspondence after July 1st should be addressed to American Cyanamid & Chemical Corporation at the same address to which you have been accustomed to send letters or other communications. In addition to the above, the activities of the following companies have at the same time been placed under the control of American Cyanamid & Chemical Corporation:

AMERICAN POWDER COMPANY
THE SELDEN COMPANY
STRUCTURAL GYPSUM CORPORATION
OWL FUMIGATING CORPORATION
THE KALBFLEISCH CORPORATION OF SURINAM

We believe that this consolidation of activities will enable us to render even better service to the trade, and look forward to the increased opportunity of continuing the established relationship with our friends and customers.

AMERICAN CYANAMID & CHEMICAL CORPORATION
535 FIFTH AVENUE, NEW YORK

Highland-Western Factories Sold

Following the publication early in June of the fact that the Highland-Western Glass Company had been acquired by the Mississippi Glass Company, an injunction was filed in the Chancery Court, Wilmington, Del., against the Highland-Western Company of Washington, Pa., by Baird Mitchell and John O. Tucker, trading as Mitchell, Tucker & Co., and claiming to own stock in the Highland-Western Company, requesting that the proposed sale of the concern's assets to the Mississippi Glass Company of New York be enjoined. An answer to the injunction suit was made on June 10th by the Highland-Western Glass Co., of Washington, Pa., asserting that the sale was fair and equitable to stockholders, insured them maximum safety for their investments and that it will result in a more generally stabilized condition in the rolled glass industry. It further asserted that the best interests of the company would be conserved by permitting the sale to be consummated.

Motor Vehicle Registration

The motor vehicle owners in the United States in 1931 paid license fees of $344,337,654, according to data collected by the Bureau of Public Records of the Department of Agriculture at Washington. New York State led with 2,297,249 motor vehicles, California followed next. The total registration for the country represents a decrease of 2.8% from the 1930 report. A small decrease occurring in the number of trucks, the total registered in 1931 amounting to 3,466,303. The figures for 1931 do not include 172,250 tax exempt official vehicles. Almost the entire income from this source was appropriated for road building, divided as follows: State highways, $2,733,786, local roads $70,043,625, payments on road bonds $42,574,464, collection and administration $19,688,604.

Plate Glass Production in May

Figures compiled by P. A. Hughes show the total production of polished plate glass by the member companies of the Plate Glass Manufacturers of America for the month of May, 1932, was 3,015,943 sq. ft., as compared to 5,025,008 sq. ft. produced by the same companies in the preceding month, April, 1932, and 8,451,230 sq. ft. produced by the Association members in the corresponding month last year, May, 1931.

The Tariff Hearing on laminated products set for July 7 has been postponed to a date to be announced later.

Glass Men Meet at Keuka Lake

(*Continued from page* 125)

dents, that it is useless to correspond with them.

By way of relaxation, the entire force of scientific, engineering, and administrative talent were turned loose on the domestic pump. Eight hours work by six or eight men failed to make the pump work or reveal why it didn't. It was concluded that in New York State the laws of nature must be against water-drinking. Fortunately the vine grows plentifully on the neighboring hills.

Two members of the expedition found a crow's nest, and Dr. Littleton went up to investigate, finding three young crows, which his sons later fetched from the tree top. Messrs. Flint and Hostetter produced an excellent mess of lake trout, but some suspicion attaches to their source of supply.

The writer in an innocent moment mentioned that in Australia there are earthworms six feet long. These worms proved too big for Francis Flint to swallow, and he is proposing the excommunication of the story-teller until the worm is produced in person.

F. W. PRESTON.

PERFORMANCE talks

In Photo A, the Port Bottom Blocks are Made of Mix 89!

Look at these two photos carefully. They were taken after a recent run at the Harding Glass Co., Fort Smith, Ark. The materials shown in each port were, of course, installed in this furnace at the same time.

In Photo A, the bottom blocks are made of Laclede-Christy's Mix 89. There is but little incrustation. No cracking. No dripping. No fusion.

In Photo B, the bottom blocks are made of a *much higher-priced* competitive material. Note the crack and erosion; the incrustation all over the surface; and the fusion of surrounding silica material.

MORAL: Use dependable, tried-and-proved Mix 89. It's not only cheaper; it's *better!*

You will get better results if you buy your Fire Brick, Checker Tile, and High Temperature Mortars and Cements from the Glass Industry Specialists.

LACLEDE-CHRISTY, ST. LOUIS, U. S. A.

Mix 89

A LACLEDE-CHRISTY PRODUCT

Current Prices of Glass-Making Materials

June 24, 1932

Quotations furnished by various producers, manufacturers and dealers.

Acid		Carlots	Less Carlots
Citric (dom.)	lb.	..	.30
Hydrochloric (HCl) 20° tanks, per 100 lb		..	1.10
Hydrofluoric (HF) 60% (lead carboy)	lb	..	.12½
52% and 48%	lb.	.10	.10-.11½
Nitric (HNO_3) 38° carboy ext. Per 100 lb.		5.50	..
Sulphuric (H_2SO_4) 66° tank cars	tor.	5.50	..
Tartaric	lb.	..	.23½
Alcohol, denatured	gal.	..	..
Aluminum hydrate ($Al(OH)_3$)	lb.	.04½-.05	.05½-.06
Aluminum oxide (Al_2O_3)	lb	..	.07
Ammonium bifluoride (NH_4) FHF	lb.	..	.15½
Ammonia water (NH_4OH) 26° drums	lb.	..	..
Antimony, metallic (Sb)	lb	.02½	.02¾
Antimony oxide (Sb_2O_3)	lb.	..	.09¾
Antimony sulphide (Sb_2S_3)	lb	..	.08½
Arsenic trioxide (As_2O_3) (dense white), 99%	lb	.04	.14 .04½
Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh	ton	47.00	..
90% through 100 mesh	ton	44.00	..
Barium hydrate ($Ba(OH)_2$)	lb.	..	.05¼
Barium mixture, glassmaker's, f.o.b. St. Louis	ton	25.00	..
Barium nitrate ($Ba(NO_3)_2$)	lb.	..	.07¼
Barium selenite ($BaSeO_3$)	lb.	..	..
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk, f.o.b. shipping point,	ton	15.00-16.00	18.00
Bone ash	carlots, lb.	.06	.06½
Borax ($Na_2B_4O_7 10H_2O$)	lb.	..	.02¼-.02¾
Granulated	lb.	.02-.02½	.02¼-.02¾
Powdered	lb.	.02¼-.02¾	..
Boric acid (H_3BO_3)	lb.	.04¼-.05¼	..
Cadmium sulphide (CdS)—			
Red	lb	..	.65-.90
Orange	lb	..	.60-1.10
Yellow	lb		1.30-1.50
Chromium oxide (Cr_2O_3)	lb	.18½	.19
Cobalt oxide (Co_2O_3)			
In bbls.	lb	..	1.25-1.35
In 10 lb. tins	lb	..	1.35
Copper oxide			
Red (Cu_2O)	lb	..	.25
Black (CuO)	lb	..	.17-.19
Black prepared	lb	..	.22
Cryolite ($Na_3Al F_6$) Natural Greenland Kryolith)	lb	.09	.09¼
Synthetic (Artificial)	lb.	..	.09½
Epsom salts ($MgSO_4$) (imported) Per 100 lb		..	1.15-1.20
*Feldspar—			
100 mesh	tor.	11.50-17.50	12.00-18.00
80 mesh	tor.	11.00-11.50	13.00
40 mesh	tor.	10.75-11.00	12.00
20 mesh	ton	9.50-11.00	..
Fluorspar (CaF_2) domestic, ground. 96-98% (max SiO_2 2½%)			
Bulk, carloads, f.o.b. mines	tor.	30.00	..
In bags or barrels	ton	34.00	39.00
Imported	ton	30.00-31.00	33.00-37.00
Formaldehyde	lb	..	.07
Graphite (C)	lb	..	04-.07
Iron oxide—			
Red (Fe_2O_3)	lb	..	.0425
Black (FeO)	lb	.04½	..
Kaolin (f.o.b. mine)	tor.	8.00-9.00	..
English, lump, f.o.b. New York	tor.	14.50-25.00	24.50-30.00

*Spot Shipments.

Kryolith (see Cryolite)		Carlots	Less Carlots
Lead caromate ($PbCrO_4$)	lb.	..	.30
Lead oxide (Pb_3O_4) (red lead)	lb	.0550	.0675
Litharge (PbO)	lb.	.0450	.0575
Lime—			
Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	5.50	..
Burnt (CaO) ground, in bulk	ton	5.00	..
Burnt, ground, in paper sacks	ton	7.00	..
Burnt, ground, in 280 lb. bbls. Per bbl.		2.15	..
Limestone ($CaCO_3$)		1.50-2.50	..
Magnesia (MgO)—			
Calcined, heavy (in bbls.)	lb	.06	.07
light (in bbls.)	lb	..	.23
extra light (in bbls.)	lb		.37
Magnesium carbonate ($MgCO_3$)	lb	.06	.10
Manganese 85% (MnO_2)	lb.	.02	.03
Nickel oxide (Ni_2O_3), black— for nickel content	lb	..	.35
Nickel monoxide (NiO), green— for nickel content	lb		.35
Plaster of Paris, bags	ton	21.00	23.00-29.00
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals	lb	.09	.09¼
Ground	lb	11	.12
Potassium carbonate—94-96%	lb.	.0555	.0555
Calcined (K_2CO_3) 96-98%	lb	.06¼	.07
Hydrated 80-85%	lb	.05¾	.06¼
Potassium chromate (K_2CrO_4)	lb.	..	.25
Potassium hydrate (KOH) (caustic potash)	lb	.07⅛	.08
Potassium nitrate (KNO_3) (gran.)	lb.	..	.06-.06¼
Potassium permanganate ($KMnO_4$)	lb.	.16½	.17½
Powdered blue	lb.	..	1.35
Rochelle salts, bbls.	lb.	..	.15
Rouge	lb.	..	..
Rutile (TiO_2) powdered, 95%	lb.	.15-.20	.20-.25
Salt cake, glassmakers (Na_2SO_4)	ton	22.00	..
Selenium (Se)	lb	..	1.70
Silver nitrate ($AgNO_3$) (100 oz.) per oz		..	.20¾
Soda ash (Na_2CO_3) dense, 58%—			
Bulk, on contract	Flat per 100 lb	1.05	..
In barrels	Per 100 lb.	1.38	1.90-2.13
In bags	Per 100 lb.	1.17½	1.72½-1.92½
Spot orders.. .025 per 100 lbs. higher			..
Sodium bichromate ($Na_2Cr_2O_7$)	lb	.07	.07½
Sodium hydrate ($NaOH$) (caustic soda) Solid	Per 100 lb	2.50	..
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls.	lb.	..	..
95 per cent.	Per 100 lb.	1.67-177	1.73-1.82
Sodium selenite (Na_2SeO_3)	lb		2.00
Sodium fluosilicate (Na_2SiF_6)	lb	.05½	.06
Sodium uranate (Na_2UO_4) Yellow or Orange	lb	..	1.50-1.55
Sulphur (S)—			
Flowers, in bbls.	Per 100 lb	3.45	3.80-4.00
Flowers, in bags	Per 100 lb	3.10	3.45-3.65
Flour, heavy in bbls.	Per 100 lb	2.85	3.20-3.40
Tin chloride ($SnCl_2$) (crystals)	lb	.37½	.39
Tin oxide (SnO_2) in bbls.	lb	.28	.29½
Uranium oxide (UO_2) (black, 96% U_3O_4) 100 lb. lots. Black	lb	..	2.75
Yellow	lb	..	1.50
Zinc oxide (ZnO)	lb	08½	..
American process. Bags	lb	.05¾	.06
Zircon			
Granular (Milled .005-.02c higher)		07	07½-.08
Crude. Gran. (Milled .005-.02c higher		03½	.04-.05

Monthly Summary of United States Foreign Commerce in Glass

EXPORTS

Corrected to May 24, 1932.

	April 1931 Quantity	April 1931 Value	April 1932 Quantity	April 1932 Value	Four Months Ending April 1931 Quantity	Four Months Ending April 1931 Value	Four Months Ending April 1932 Quantity	Four Months Ending April 1932 Value
Glass and glass products (Total)	.....	$701,524	.....	$371,060	.....	$2,805,543	.....	$1,542,167
Plate and window glass—								
Window glass, common, box 50 sq. ft.	1,006	4,638	155	950	3,308	17,024	661	3,909
Plate glass, unsilvered, sq. ft.	458,927	140,866	208,983	63,114	1,683,887	514,677	1,293,287	357,837
Other window and plate glass lbs.	256,197	32,916	51,733	9,131	1,154,317	131,036	474,456	53,746
Glass containers (bottles, vials and jars)	.....	193,930	.....	91,961	.....	780,690	.....	368,313
Table glassware, plain	.....	103,922	.....	54,348	.....	348,444	.....	175,060
Table and other glassware, cut or engraved	.....	7,034	.....	3,484	.....	26,102	.....	16,637
Lamp chimneys and lantern globes lbs.	.....	7,437	.....	9,235	.....	37,876	.....	25,696
Globes and shades for lighting fixtures lbs.	.....	37,177	.....	20,414	.....	159,606	.....	74,504
Chemical glassware lbs.	12,331	11,572	8,313	7,781	49,974	49,988	35,530	35,788
Electrical glassware, except for lighting lbs.	107,753	5,619	170,638	6,654	499,596	37,526	445,175	17,814
Other glassware	.....	156,413	.....	103,988	.....	702,574	.....	412 863

IMPORTS

Corrected to May 24, 1932.

Glass and glass products	.....	$455.817	.....	$256,203	.....	$2,001,906	.....	$1.113.383
Cylinder, crown, and sheet—								
Plain dut. lb.	434,601	16,807	419,718	12.462	3 392,890	134,271	1,046.958	36,443
Bent, beveled, colored, etc. dut. lb.	126,782	18.505	53,044	13,961	734,240	94,396	262,898	55,516
Plate glass dut. sq. ft.	342,394	111,953	70,012	13.259	1,596 425	475,471	578.660	100.655
Glass mirrors	143	505	1,302	456	571	1,339	1.974	2,030
Rolled, cylinder, crown, and sheet glass, ground, obscured, bent, beveled, colored, etc.	.....	5.241	.....	2,692	.....	16,669	.....	36,574
Laminated glass and manufactures, and plated glass	.....	83	.....	34	.....	3,799	.....	2,968
Bottles, vials, jars, and other containers	.....	36.766	.....	26.696	.....	178 707	.....	101,085
Scientific articles and utensils dut.	.....	37.896	.....	22.828	.....	122.985	.....	85,757
Tubes and rods dut.	.....	8 962	.....	7.763	.....	41.252	.....	26,823
Illuminating articles dut.	.....	32,201	.....	16,325	.....	126,873	.....	69,353
Blown glass articles—								
Bulbs for electric lamps, without filament dut.	973,202	11.354	1,048,672	8.604	5,077,989	49,438	4,728,940	38,251
Other blown glass articles dut.	.....	81,573	.....	58.627	.....	437 918	.....	303,082
Pressed glass articles	.....	10.144	.....	10.493	.....	46,047	.....	39,280
Other glassware	.....	83,827	.....	62,003	.....	272,741	.....	215,596